Ch4.3.doc
Created on 5/7/2002 9:33 AM
Last saved by Kay Caromile

STREAM HABITAT RESTORATION GUIDELINES

Planning, design and ecological considerations in process-based natural channel design for habitat restoration and mitigation, include channel configuration, riparian function, sediment transport, hyporheic function and flood plain connectivity. Channel design parameters are addressed, including specific habitats (spawning, rearing, holding, riparian, etc.), habitat forming structures, and off-channel habitats. Page estimates are averages for budgeting purposes and may vary for specific sections but not overall.

1 HEADING PLACEHOLDER – DO NOT DELETE

2 HEADING PLACEHOLDER – DO NOT DELETE

3 HEADING PLACEHOLDER – DO NOT DELETE

4 SELECTING A RESTORATION APPROACH

4.1 Heading Placeholder – Do Not Delete

4.2 Heading Placeholder – Do Not Delete

4.3 Factors to Consider in Identifying and Selecting an Approach

(3-4 pages for following sections in total)

Habitat restoration projects are more likely to be successful in the long-term, and to produce habitat and ecological benefits, if the implications of various approaches are carefully considered in the selection process. Consideration of the implications of a project may include evaluation of: existing or future watershed condition; project scale; the time frame necessary to achieve desired results; the longevity of benefits; operations and maintenance needs; environmental impacts associated with implementation; uncertainty of achieving desired results; and cost effectiveness of varying approaches.

For example, the objective of creating habitat components that are lacking in a particular system may be addressed through either creation of habitat features at specific sites, or through re-establishing natural process. The construction of habitat features may provide immediate habitat value, address project objectives, and be relatively inexpensive, but provide only short-lived benefit that requires significant maintenance. Alternatively, an approach that encourages re-establishment of natural process may be very expensive in the short-term and require years to realize measurable benefits, but may prove cost-effective in the long-term, require no maintenance, and provide more environmental and habitat benefits.

Project considerations in selecting an approach can be summarized to some extent by considering the "doability" and "durability" of the project. "Doability" refers to the degree to which an approach is technically and financially sound and feasible. Is the design a good one that is supportable given existing hydrology and fluvial geomorphology? Is the design vision an accurate and ecologically appropriate reflection of a reference reach or known previous channel morphology and riparian ecology? Are equipment, living and inert materials, and labor available? Is the timing right? Can weeds be controlled and irrigation supplied? Is the proposal funded?

"Durability" refers to the probability that the desired future condition will occur and persist in the landscape through time. What permit conditions, bid package provisions, contract provisions, expert construction oversight, performance bonding, contingency planning, environmental monitoring, and inspection requirements are in place to assure the project is completed as designed, and that the desired future condition is achieved and persists in the landscape through time. Consideration of all aspects of doability and durability will help frame the possible alternatives from which a final approach may be selected.

4.3.1 Existing or Future Watershed Condition

Habitat restoration, ideally, will result in "natural" conditions where natural geomorphic and ecological processes maintain habitat function. However, "natural" conditions must be viewed in the context of current and future conditions of land use and development within a watershed. Natural, in the purest sense of pristine, pre-settlement condition, may be impossible to achieve given permanent or predicted landscape changes. Thus, intended resultant conditions must be considered within the context of realistic rehabilitation of site, reach, and watershed landscapes.

When selecting projects within watersheds that have been, or are in the process of being subjected to permanent or semi-permanent landscape change, (e.g., urban development or widespread agricultural land use) achieving natural conditions may be limited to the creation of a channel system which promotes natural process and function under the new hydrologic and sediment regime.

4.3.2 Scale of Project

Stream habitat restoration may be implemented at virtually any scale, ranging from placement of a single habitat structure, to alteration of watershed-wide land use practices. The scale of the project approach will be highly dependent upon specific project objectives, the size of the stream or river in question, and the cause of problems. Site-specific disturbances may be remedied on small scales; systemic disequilibrium may require a watershed-wide project approach.

A general rule of thumb for determining what scale of restorative action is necessary is to match the scale of the action to the scale of the problem. For example, assessment of habitat condition may identify sediment resulting from upstream agricultural practices as a limiting factor for spawning. While cleaning gravels may alleviate the limiting factor on a site scale, the source of the sediment may be ignored, resulting in only short term and site-specific benefits. Such actions would have to be repeated regularly to result in benefit. Thus, the appropriate scale of restorative action in this case would preferably be modifying agricultural practices to minimize sediment inputs.

The size of the stream will not likely determine the scope of the project. Either a small stream or a large river with systemic process disequilibrium resulting from watershed scale impacts may require a watershed-scale approach to restoring process. Alternatively, a site-specific problem on a large rivers or small streams may be appropriately remedied through a site-specific technique. Thus, the size of the stream or river dictates the scale of the effort, but not necessarily the scope of the project.

The scale of an achievable project may be dictated by property, jurisdictional, and funding limitations. These limitations must be balanced with the reduced potential for success. Placeholder: Elaborate on this for 90%.

Also address how far reaching the effects will be (site, reach, or watershed scale)?

4.3.3 Delay to Results

Healthy natural systems are the product of complex interactions of multiple variables over time. Restoration activities give a river a starting point from which further interaction, and time, will bring about natural function and health. Realistic objectives for restoration activities will likely have to accept some degree of lag time between completion of physical restoration activities and realization of full habitat potential. Furthermore, different processes and functional components will recover or regenerate at different rates:

- Food (macroinvertebrate and vegetal) production may be restored on a scale of months to years following restoration activities (and associated disturbance)/
- Physical habitat features (pools, rearing, etc.) may be achieved immediately if designed as direct habitat creation to supplement or jump-start the process restoration. Processed-based and managed input approach to restoration may depend on high flow events to achieve desired function (such as sorting or armoring of bed substrate). As a result, the desired function may not be achieved until after a number of seasons or years.
- Vegetation may require decades to centuries to recover. While riparian shrub species may reach maturity in both size and composition within decades, riparian forests may require centuries for full recovery.
- Geomorphic processes may be restored within a time frame of immediate recovery to years.

The period between restoration actions and recovery or regeneration of habitat may require multiple growing seasons or a number of high flow events. During this lag time there may be lost opportunity in habitat value. Greater immediate habitat value may be attained through direct restoration of habitat, such as channel reconfiguration or wood placement. Thus, consideration of combining direct habitat restoration with process-oriented approaches may maximize short- and long-term habitat potential and minimize opportunity cost.

4.3.4 Longevity and Durability

Varying approaches to habitat restoration will have varying durability and longevity. Durability refers to a specific feature's ability to withstand the various forces that it is subjected to. For example, a debris jam may be designed to withstand a moderate flow (low durability) or an extreme flow (high durability). Longevity refers to the duration of benefit gained by restorative action, or quite simply, how long it will last.

The ideal objective is to strive for self-sustaining and adaptive projects, thereby creating indefinite longevity. Restoration activities that promote natural processes rather than creating specific habitats will generally result in greater longevity. The design life (longevity) of most direct habitat creation projects, and particularly structural treatments such as log and boulder placements, will be related to the magnitude of hydrologic events which may destabilize them. Because the magnitude of hydrologic events is a largely unpredictable variable, it may be impossible to determine the longevity of created habitat. Furthermore, structural approaches may have design lives that exceed functional life. For example, while a structural approach may survive a design flow event, and last through a predicted design life, the function provided by that structure may be lost due to a change in the channel relative to the structure. For example, a debris jam placed to create scour, deposition and provide cover and spawning habitat may be left high and dry by a natural shift in channel location.

The functional life of restoration projects will be influenced by:

- Chance and random geologic and hydrologic events, including sediment inputs and floods.
- Land use and land tenure arrangements, including changes in land use regulations, easements, and ownership.
- System stability and watershed impacts.
- Recovery time to full potential.

4.3.5 Operations and Maintenance Needs

An emphasis on self-sustaining, process based approaches to habitat restoration will promote self-sustaining, maintenance-free projects. The best restoration project design and approach, however, may still require some period of operation and maintenance to maximize the rate of recovery. Operations are activities that are anticipated and required by design for proper function of implemented projects. Examples of operations may include irrigation of planted materials, management of flows from impoundments, managed grazing of riparian corridors, inputs of gravels, wood, or nutrients in deficient systems, or the removal of any temporary components such as erosion control measures. Maintenance is any activity that becomes necessary through normal degradation or as a result of unexpected conditions before a project becomes self-sufficient. Examples of maintenance may include the repair or replacement of damaged structures or failed project components.

Ch4.3.doc
Created on 5/7/2002 9:33 AM
Last saved by Kay Caromile

Examples of short-term operations and maintenance activities that may be necessary, even for process-based restoration approaches, include:

- Weeding and irrigation of plantings.
- Repair and replacement of structural components (define—such as,,,) that are intended to provide short-term habitat value.
- Repair and replacement of temporary soil erosion control measures.
- Fencing of riparian corridors.

Examples of long-term operations and maintenance activities that may be necessary, even for process-based restoration approaches, include:

- Flow management from dams and impoundments.
- Managed inputs of material (sediment, wood, nutrients) to streams whose sources have been permanently modified.
- Monitoring and maintenance of fences.
- Negotiation of easements following land transfers.

Operations and maintenance are project and site specific considerations and will be dictated by both anticipated and unanticipated conditions and events. Typical operations and maintenance requirements for various techniques are provided in each technique description. Maintenance needs are highest when using a managed inputs approach or a direct habitat creation approach. Maintenance needs increase when the restoration design does not take into account existing and future watershed conditions or when design does not attempt to restore natural stream geomorphology or take into account hydraulics or design treats only the symptom and not the cause of a problem.

Placeholder – examples to illustrate concepts in previous paragraph to be provided at 90% based on level of effort requested.

4.3.6 Environmental Impact

Aquatic and terrestrial stream and riparian systems involve complex interactions and responses among numerous variables including climate, geology, vegetation, presence of organisms, and human-imposed limitations. These variables may change gradually or dramatically either spatially or temporally. Generally, any change to inputs or variables will result in change to processes and habitats. The following general environmental impacts may occur either on-site and off-site (upstream and downstream) as a result of project implementation:

Question: Is the term "environmental impact" restricted to negative impacts are does it include positive impacts as well?

- Aquatic impacts associated with construction and equipment:
  - Water quality impacts such as increased turbidity or fuel spills
  - Disturbance of existing aquatic life and habitat.
- Riparian impacts, particularly those associated with access and staging areas for any

construction components of the project.
    - Soil compaction
    - Removal of vegetation, snags, wood, and duff layer
    - Spreading noxious weeds
    - Disturbance of wildlife
- Terrestrial impacts associated with access and staging areas for any construction components of the project.
    - Soil compaction
    - Removal of vegetation, snags, wood, and duff layer
    - Spreading of noxious weeds
    - Disturbance of wildlife
- Marine impacts may be realized if the project scale includes a significant portion of a watershed or if it is in close proximity to marine environments.

Construction projects invariably involve some degree of disturbance. This disturbance can be greatly minimized if the project is properly designed and constructed, and if ongoing monitoring and maintenance is conducted. A minimum of disturbance may be necessary, and acceptable, to achieve the desired outcome in the long term. For example, access to a stream channel may require transport of materials and equipment across a healthy riparian plant community. In such a case, extreme measures may be necessary to minimize disturbance, and to reclaim all impacts, including soil compaction and reestablishment of vegetation. Spread of noxious weeds is a common and challenging negative impact from any soil disturbance in more arid portions of central and eastern Washington. Environmental impacts that are common to particular techniques are discussed in the individual technique descriptions.

Negative impacts are less when restoration efforts take place outside of the stream channel. For instance….

4.3.7 Risk Assessment

Different approaches to a given project objective may involve varying degrees of risk – risk of compromising a natural resource, property, or infrastructure - and may offer varying degrees of certainty of success. These risks and the probability of success are weighed with other project considerations described above. Risk should be considered in both the long-term and short-term.
Short-term risks are those associated with implementation/construction and include primarily the environmental impacts listed above. Additionally, some projects may pose safety hazards to boaters, which would be considered a short-term risk. Long-term risks are those associated with the eventual failure of a project, in the case of structural features, or the potential for the project to have unexpected impacts over time. For example, a constructed debris jam may fail years after installation, either during or beyond its design life, and result in damage to downstream infrastructure such as bridges or to downstream property. Risks that are associated with specific techniques are discussed in the individual technique descriptions

Ch4.3.doc
Created on 5/7/2002 9:33 AM
Last saved by Kay Caromile

Certainty of success is the likelihood that a project will meet its objective. The possibility that a project will not meet its objectives can be considered as a risk. Certainty varies among techniques, the level of design effort, the information available, and experience with the technique.

Following is a list of example situations that may result in higher risk, or reduced certainty of success:
[Modify and move discussion in 4.4.11 to here]

- Failure to perform thorough reach and watershed assessments can reduce the certainty of success and increase risk if problem causes are not fully understood and identified.
- Proximity to infrastructure can increase risk for structural projects.
- Certainty of success may be limited by using passive approaches to restoration when habitat objectives are specific.

4.3.8 Cost Effectiveness

Cost effectiveness is defined as cost of the project relative to the benefits of the achieved result. Cost effectiveness should take into account assessment, design, and construction costs as well as long-term monitoring and maintenance requirements over time. Costs will vary with the technique employed, particularly when both a passive and an active approach are considered. An example of an *active* approach is planting riparian vegetation. An example of a *passive* approach is fencing a riparian corridor, and waiting for an appropriate late seral stage riparian plant community to develop over time. While the same end goal may be achieved through a passive and an active approach, and passive is more cost effective, the waiting time may not justify savings.

Cost effectiveness is highly dependent upon the time frame over which the costs and benefits are realized. For example for projects that can be considered self-sustaining in perpetuity, the cost: benefit ratio may become very favorable. Alternatively, projects that require regular maintenance or inputs, or which require extensive long-term monitoring may exhibit low cost: benefit ratios.

The challenge in consideration of cost: benefit ratios is often in determining the value of the benefit. General project costs are discussed in the individual technique description. Costs can usually be readily determined in dollar units; benefits are often impossible to evaluate in dollar value. Thus, the consideration of costs and benefits is generally a qualitative evaluation. Furthermore, project costs are invariably related to the degree of risk that is acceptable to assume – there is usually an inverse relationship between the two.